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For: Restartable Database Loads Using ...
Contact: John D. Cowart/858-485-4903
Sheet 1 of 14

CLIENT — 115

SERVER — 110

RDBMS — 100
TABLE — 105

FIG. 1

(PRIOR ART)

LOAD — 210

ODS — 200

DATA WARE-HOUSE — 205

UNLOAD — 215

FIG. 2

(PRIOR ART)

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        Sheet 2 of 14

FIG. 3

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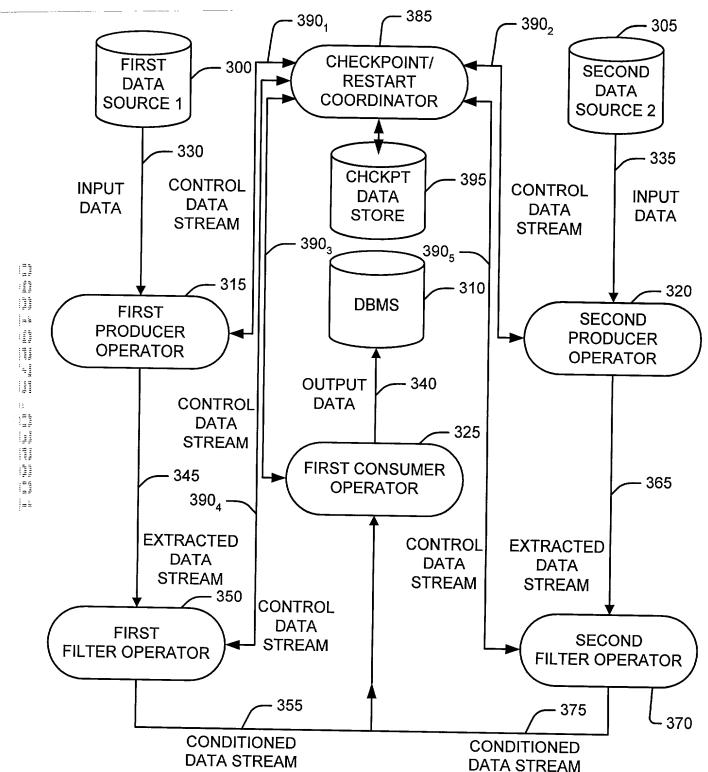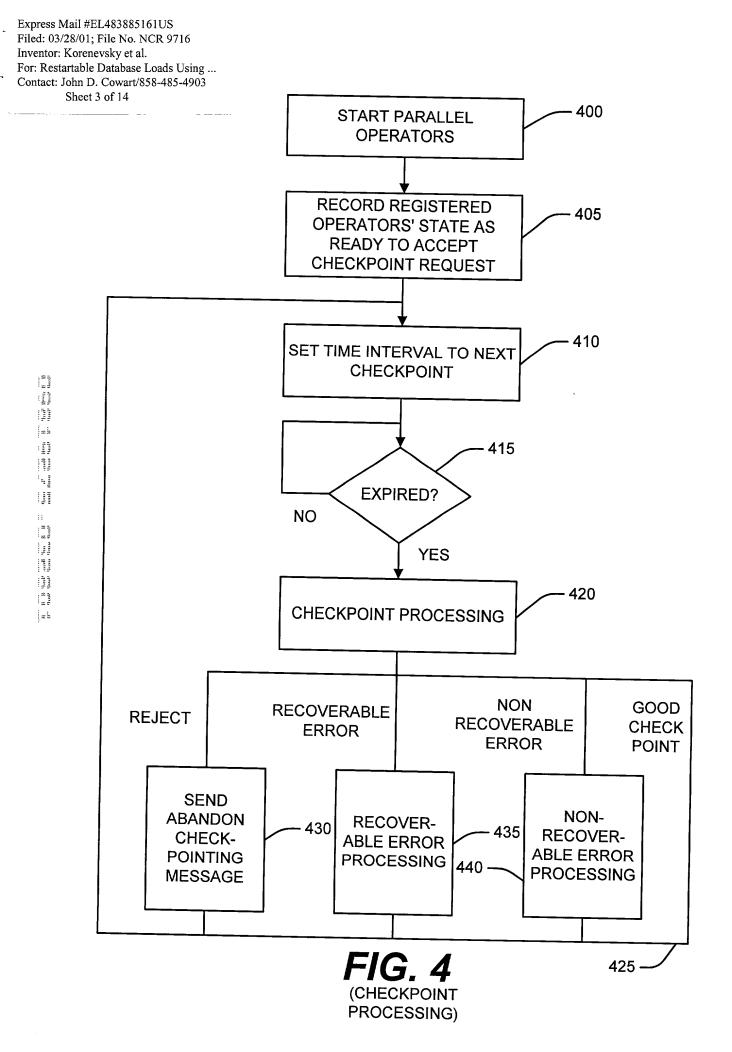Inventor: Korenevsky et al.
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Sheet 3 of 14

START PARALLEL
OPERATORS — 400

RECORD REGISTERED
OPERATORS' STATE AS
READY TO ACCEPT
CHECKPOINT REQUEST — 405

SET TIME INTERVAL TO NEXT
CHECKPOINT — 410

EXPIRED? — 415

NO

YES

CHECKPOINT PROCESSING — 420

REJECT

RECOVERABLE
ERROR

NON
RECOVERABLE
ERROR

GOOD
CHECK
POINT

SEND
ABANDON
CHECK-
POINTING
MESSAGE — 430

RECOVER-
ABLE ERROR
PROCESSING — 435

NON-
RECOVER-
ABLE ERROR
PROCESSING

440

425

FIG. 4
(CHECKPOINT
PROCESSING)

OPERATOR 1   CRCF   OPERATOR 2

READY
515

READY
520

525

CHKPT REQUEST
530

CHKPT REQUEST
535

RECEIVE CPM   560

570   RECEIVE CPM

SEND CPM   565

575   SEND CPM

CHECKPOINT
540

CHECKPOINT
545

PROCEED
550

PROCEED
555

500   510   505

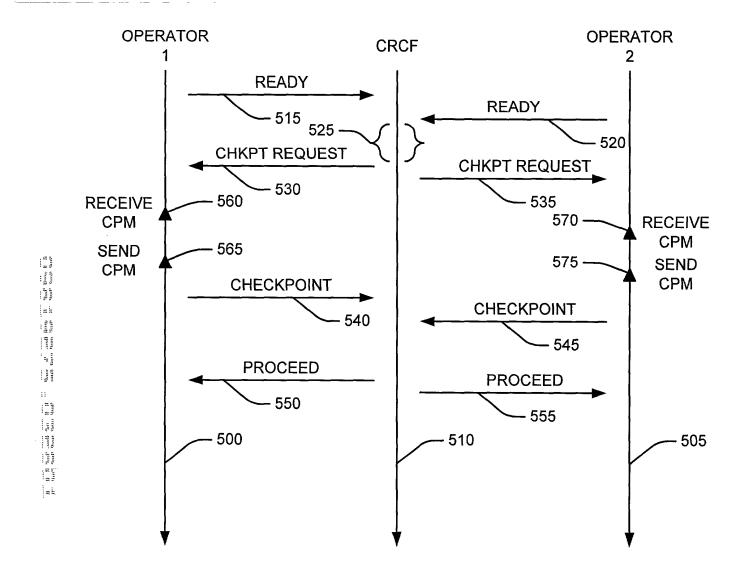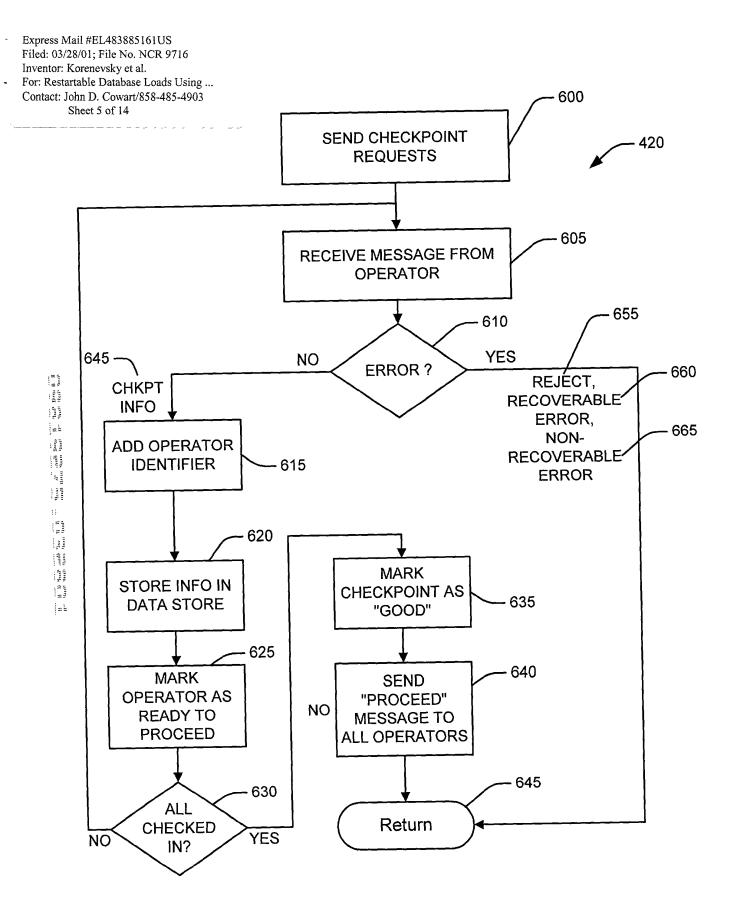# *FIG. 5*

(NORMAL
PROCESSING)

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        Sheet 5 of 14

SEND CHECKPOINT
REQUESTS ⌐ 600

⌐ 420

RECEIVE MESSAGE FROM
OPERATOR ⌐ 605

ERROR ? ⌐ 610

NO

YES ⌐ 655

REJECT,
RECOVERABLE
ERROR,
NON-
RECOVERABLE
ERROR

⌐ 660
⌐ 665

645 ⌐
CHKPT
INFO

ADD OPERATOR
IDENTIFIER ⌐ 615

STORE INFO IN
DATA STORE ⌐ 620

MARK
CHECKPOINT AS
"GOOD" ⌐ 635

MARK
OPERATOR AS
READY TO
PROCEED ⌐ 625

SEND
"PROCEED"
MESSAGE TO
ALL OPERATORS ⌐ 640

NO

ALL
CHECKED
IN? ⌐ 630

NO

YES

Return ⌐ 645

FIG. 6

OPERATOR
1

CRCF

OPERATOR
2

READY

515

READY

520

CHKPT REQUEST

530

CHKPT REQUEST

535

CHECKPOINT
REJECT

700

735

RECEIVE
CPM

ABANDON CHKPT

705

ABANDON CHKPT

710

SEND
CPM

740

RECEIVE
CPM

720

CHKPT REQUEST

745

CHKPT REQUEST

715

CHKPT REQUEST

SEND
CPM

CHECKPOINT

730

CHECKPOINT

750

CHECKPOINT

725

FIG. 7

(CHECKPOINT
REJECTED)

```
┌─────────────────────────┐
│   WAIT UNTIL ALL I/O     │── 800
│  REQUESTS ARE COMPLETE   │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│  PROCESS THE DATA IN THE │── 805
│       INPUT QUEUE        │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│   GATHER RESTART INFO    │── 810
│ FROM DATA SOURCE AND/OR  │
│         TARGET           │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│  GATHER INTERNAL RESTART │── 815
│       INFORMATION        │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│   INCLUDE RESTART INFO   │── 820
│   WITH CHECKPOINT MSG    │
└─────────────────────────┘
```

FIG. 8

```
┌─────────────────────────┐
│   RECEIVE CPM ON INPUT   │── 900
│      DATA STREAMS        │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│  FINISH WRITING DATA TO  │── 905
│   OUTPUT DATA STREAMS    │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│  SEND CPM ON OUTPUT DATA │── 910
│        STREAMS           │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│     SEND CHECKPOINT      │── 915
│        MESSAGE           │
└─────────────────────────┘
```

FIG. 9

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For: Restartable Database Loads Using ...
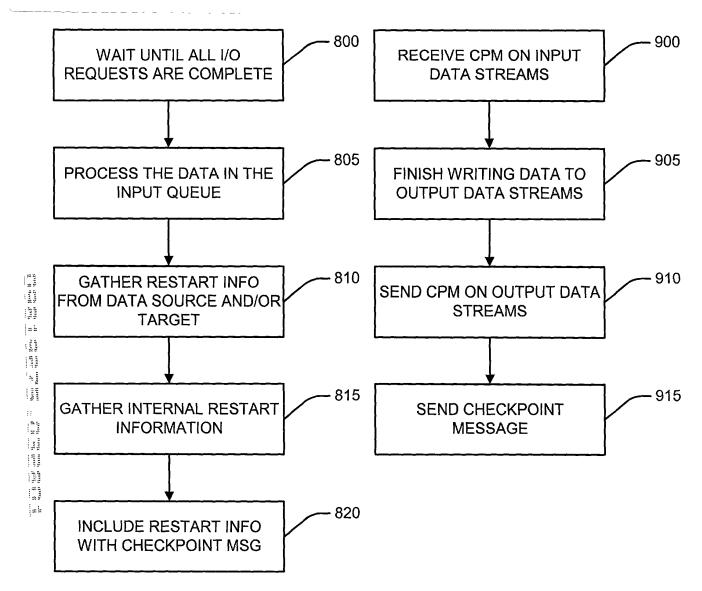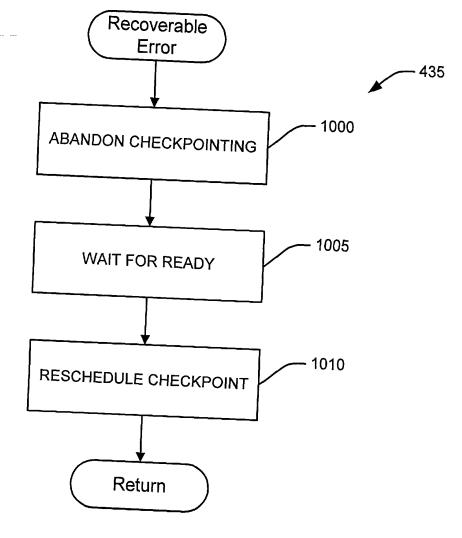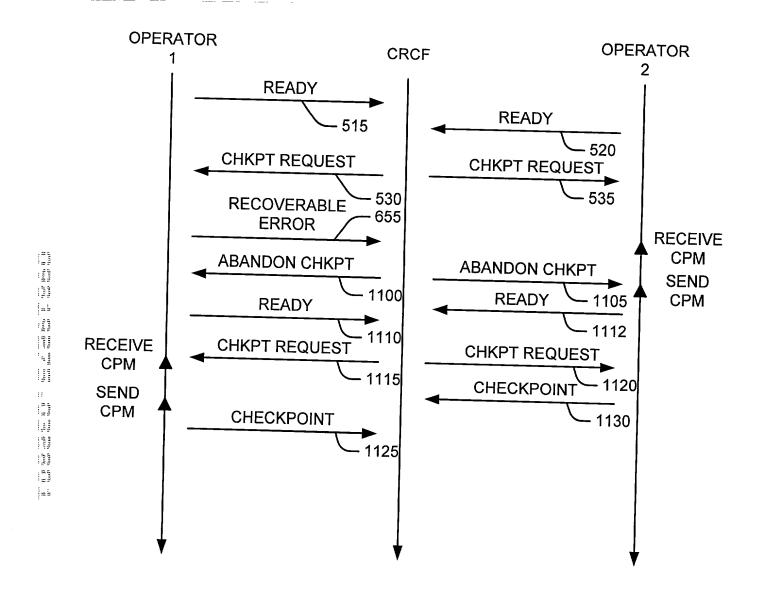Contact: John D. Cowart/858-485-4903
Sheet 8 of 14

Recoverable
Error

— 435

ABANDON CHECKPOINTING — 1000

WAIT FOR READY — 1005

RESCHEDULE CHECKPOINT — 1010

Return

FIG. 10

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          Sheet 9 of 14

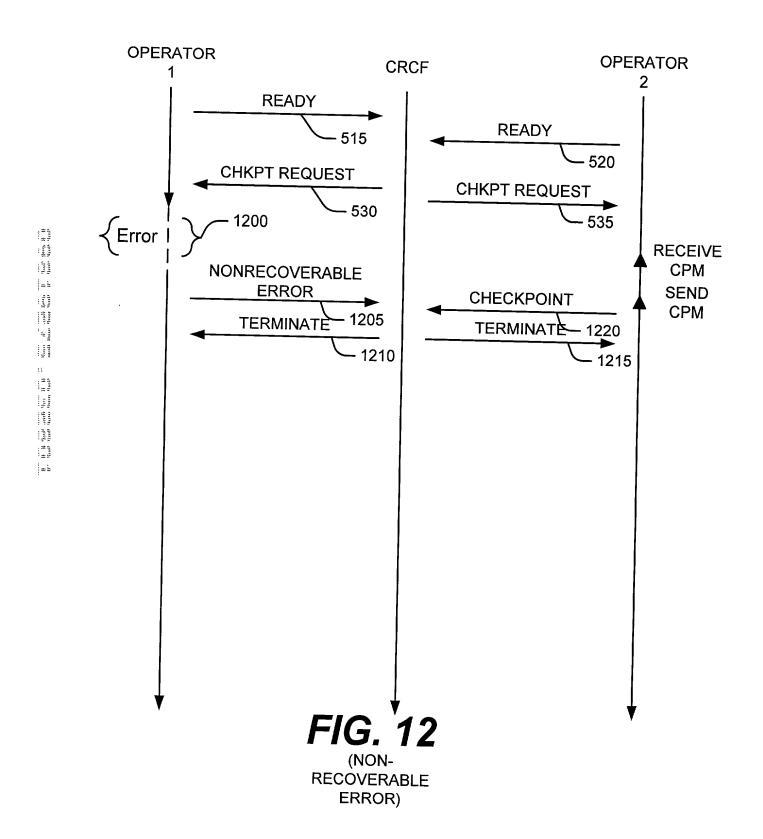OPERATOR 1   CRCF   OPERATOR 2

READY — 515

READY — 520

CHKPT REQUEST — 530

CHKPT REQUEST — 535

RECOVERABLE ERROR — 655

RECEIVE CPM

SEND CPM

ABANDON CHKPT — 1100

ABANDON CHKPT

READY — 1110

READY — 1105

— 1112

RECEIVE CPM

SEND CPM

CHKPT REQUEST — 1115

CHKPT REQUEST

CHECKPOINT — 1120

CHECKPOINT — 1125

— 1130

FIG. 11

(RECOVERABLE
ERROR)

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Contact: John D. Cowart/858-485-4903
        Sheet 10 of 14

OPERATOR
1

CRCF

OPERATOR
2

READY

515

READY

520

CHKPT REQUEST

530

CHKPT REQUEST

535

{ Error | } 1200

RECEIVE
CPM

NONRECOVERABLE
ERROR

SEND
CPM

CHECKPOINT

1205

1220

TERMINATE

TERMINATE

1210

1215

FIG. 12

(NON-
RECOVERABLE
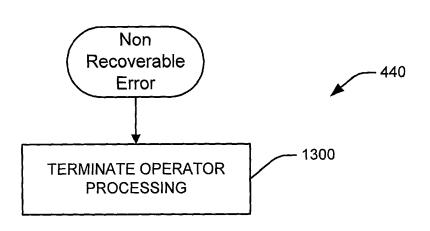ERROR)

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Inventor: Korenevsky et al.
For: Restartable Database Loads Using ...
Contact: John D. Cowart/858-485-4903
          Sheet 11 of 14

Non Recoverable Error

440

TERMINATE OPERATOR PROCESSING

1300

FIG. 13

FIG. 14

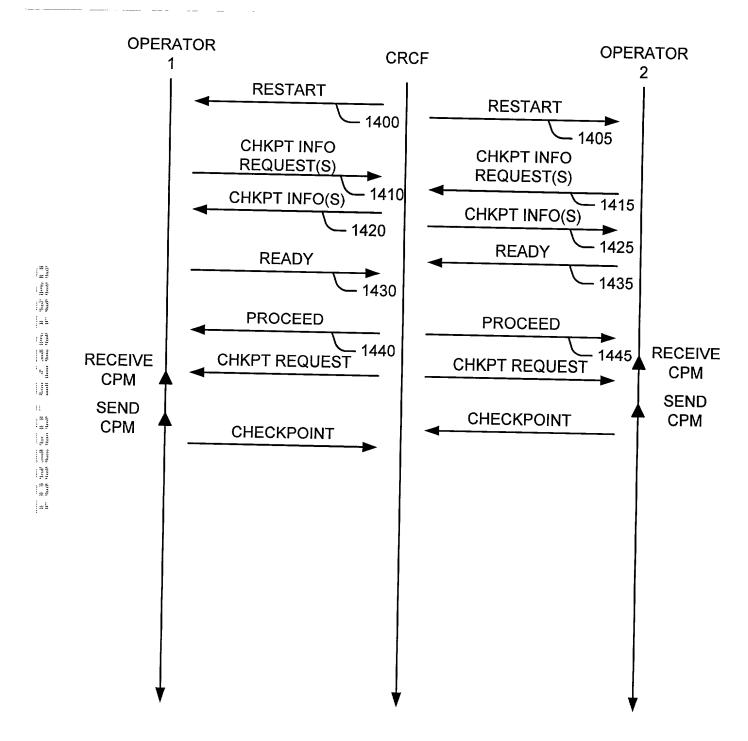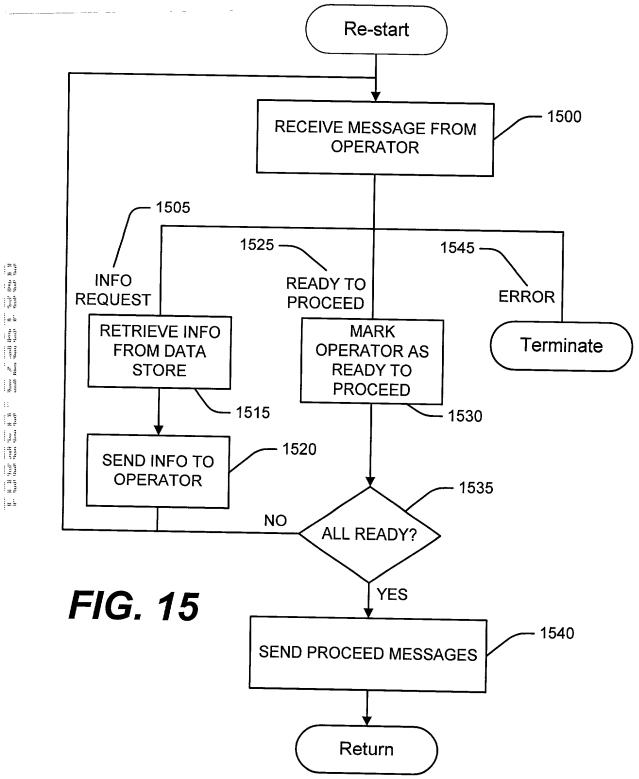(RE-START)

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For: Restartable Database Loads Using ...
Contact: John D. Cowart/858-485-4903
          Sheet 13 of 14

Re-start

RECEIVE MESSAGE FROM OPERATOR — 1500

1505

INFO REQUEST

1525 — READY TO PROCEED

1545 — ERROR

RETRIEVE INFO FROM DATA STORE

MARK OPERATOR AS READY TO PROCEED

Terminate

1515

1530

SEND INFO TO OPERATOR — 1520

ALL READY? — 1535

NO

YES

FIG. 15

SEND PROCEED MESSAGES — 1540

Return

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For: Restartable Database Loads Using ...
Contact: John D. Cowart/858-485-4903
Sheet 14 of 14

FIG. 16

CLIENT SYSTEM 1635

MAINFRAME 1630

CRCF 1640

NETWORK

EXECUTOR 1625

Node 1600₁

OPERATOR 1605₁

OPERATOR 1605₂

OPERATOR 1605₃

OPERATOR 1605ₙ

1610

Nodes 1600₂..ₙ